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DISTRIBUTION AND DEMOGRAPHICS OF MARINE MAMMALS IN SOCAL THROUGH PHOTO-IDENTIFICATION, GENETICS, AND SATELLITE TELEMETRY: A SUMMARY OF SURVEYS CONDUCTED 1 JULY 2012 – 30 JUNE 2013

by

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14. ABSTRACT

This report summarizes the year 3 results in an ongoing investigation of the distribution, demographics, and behavior of cetaceans in the U.S. Navy's SOCAL operational area. Small vessel surveys, focused primarily on the Southern California Anti-submarine Warfare Range (SOAR), were conducted in several field efforts over the 12-month period beginning in July 2012. All SOAR surveys were conducted in conjunction with visual verification tests of the M3R acoustic monitoring system, and included photo-identification, satellite tagging, and biopsy sampling. Results of photo-ID data collection over 24 survey days in Nov., Jan., and Mar. 2012/2013 on Cuvier's beaked and fin whales in Southern California are summarized. The data suggest that both species have relatively small local populations. 24 satellite tags, 18 providing dive data in addition to location data, were deployed on five cetacean species, including Cuvier's beaked and fin whales. 2 Risso's dolphins and 4 killer whales were also tagged. The killer whales included 3 offshores that moved thousands of kilometers from the study area, providing the first view of habitat use and daily movements from whales in this little known population.

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Distribution and Demographics of Marine Mammals in SOCAL through Photo-Identification, Genetics, and Satellite Telemetry: A summary of surveys conducted 1 July 2012 – 30 June 2013

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Annual progress report (year 3 of 4) for Grant N00244-10-1-0050 through the Naval Postgraduate School

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Summary

This report summarizes the results of year three in an ongoing investigation of the distribution, demographics, and behavior of cetaceans in the U.S. Navy's SOCAL operational area. This grant was initially funded through June 2013, but has received a one-year extension; thus this is an annual progress report and not a final report. As in previous years, small vessel surveys were conducted in several field efforts over the 12-month period beginning in July 2012. Surveys focused primarily on the Southern California Anti-submarine Warfare Range (SOAR), a training area in the Southern California Offshore Range (SCORE) which occupies much of the San Nicolas Basin to the west of San Clemente Island (SCI). All SOAR surveys were conducted in conjunction with visual verification tests of the M3R (*M*arine *M*ammal *M*onitoring on Navy Undersea *R*anges, Moretti *et al.* 2006) acoustic monitoring system, and included photo-identification, satellite tagging, and biopsy sampling of species of interest. A total of 24 survey days were conducted in November 2012, January 2013, and March 2013, during which we encountered 144 groups of 13 cetacean species, and sighted both transient and offshore killer whale ecotypes.

In this report we provide the first summarized results of photo-ID data collection on Cuvier's beaked whales and fin whales in Southern California. Both of these studies are suggesting that there are relatively small local populations of these two species. Twenty-four satellite tags, 18 of which provided dive data in addition to movements data, were deployed on five species for periods up to 147 days (median = 25 days). In most cases these represent the first long term dive records from the species tagged. Three Cuvier's beaked whales were tagged with depth-reporting satellite tags, which collected over 1000 hours of dive data in addition to movement data to augment the 3700 hours of dive data from beaked whale tags deployed in previous years. Thirteen tags were deployed on fin whales in this study year, ten of which collected nearly 2700 hours of dive data in addition to movements data. Four killer whales were tagged, including three offshores that moved thousands of kilometers from the study area into Alaskan waters, providing the first view of habitat use and daily movements from whales in this little known population. We also tagged two Risso's dolphins to augment the small but growing data set on movements and diving behavior from this common but little-studied species.

Introduction and Methods

Detailed background information pertinent to this project and data collection methods were provided in the year one progress report for this grant, available as an electronic document through the Naval Postgraduate School at http://edocs.nps.edu/npspubs/scholarly/TR/2011/NPS-OC-11-005CR.pdf. There were no substantive changes to these data collection and processing methods in year three.

In our year two progress report, we described a process under development to compare movements and dive behavior from satellite tagged individuals to concurrent records of sonar use within 100 km. This process is continuing for tags deployed in 2012 with no substantive changes to the methodology as described in the report available at http://calhoun.nps.edu/public/bitstream/handle/10945/13393/NPS-OC-12-002CR.pdf?sequence=3.

Results and Discussion

Effort and Sightings

A total of 24 successful surveys were conducted during three field efforts in year three; surveys were canceled on six field days in January 2013 due to poor weather conditions. We again focused surveys from late fall through early spring to target seasons that have not been well-studied historically. This year saw an increase in the proportion of effort (11 days, including transits) conducted outside the boundaries of SOAR due to conflicting range activity and/or rough weather (Table 1, Figure 1). Most of these off-SOAR days included effort immediately adjacent to SOAR or SCI, though one survey in January 2013 was conducted in the waters south and west of Long Beach in response to reports of a stable aggregation of fin whales in the area.

Table 1. Summary of survey effort by day, November 2012 - March 2013. (Note that "Total" for Species is the number of unique species identified throughout the study year, and thus not a summation across days.)

Date	Effort (Hrs)	Distance (km)	Survey Area	Sightings	Species
14-Nov-12	3.90	109.27	Dana Point-Wilson Cove	3	2
15-Nov-12	9.47	240.76	SCORE	2	2
16-Nov-12	9.70	274.10	SCORE	3	2
17-Nov-12	11.14	190.76	SCORE	4	4
18-Nov-12	8.38	127.79	SCORE	4	4
19-Nov-12	11.66	209.28	SCORE	3	2
20-Nov-12	2.64	100.01	Wilson Cove-Dana Point	1	1
04-Jan-13	3.80	103.90	Dana Point-Wilson Cove	6	4
05-Jan-13	11.56	188.90	SCORE	15	8
08-Jan-13	10.27	112.05	SCORE	4	3
09-Jan-13	10.95	207.42	SCORE	4	3
12-Jan-13	6.11	108.34	SCORE	6	4
13-Jan-13	6.20	161.68	Wilson Cove-Dana Point	4	2
16-Jan-13	7.94	192.61	LA-Long Beach	11	4
22-Mar-13	5.56	118.53	Dana Point-Wilson Cove	3	3
23-Mar-13	12.63	175.94	SCORE	12	7
24-Mar-13	11.11	205.57	SCORE	6	4
25-Mar-13	8.42	142.05	SCORE	5	4
26-Mar-13	6.64	141.31	SCORE	8	6
27-Mar-13	11.30	166.68	SCORE	13	7
28-Mar-13	11.70	185.20	SCORE	4	3
29-Mar-13	11.25	176.50	SCORE	15	7
30-Mar-13	12.49	172.42	SCORE	6	4
31-Mar-13	2.62	95.75	Wilson Cove-Dana Point	2	2
24	**207.4**	**3907**	**Totals**	**144**	**13**

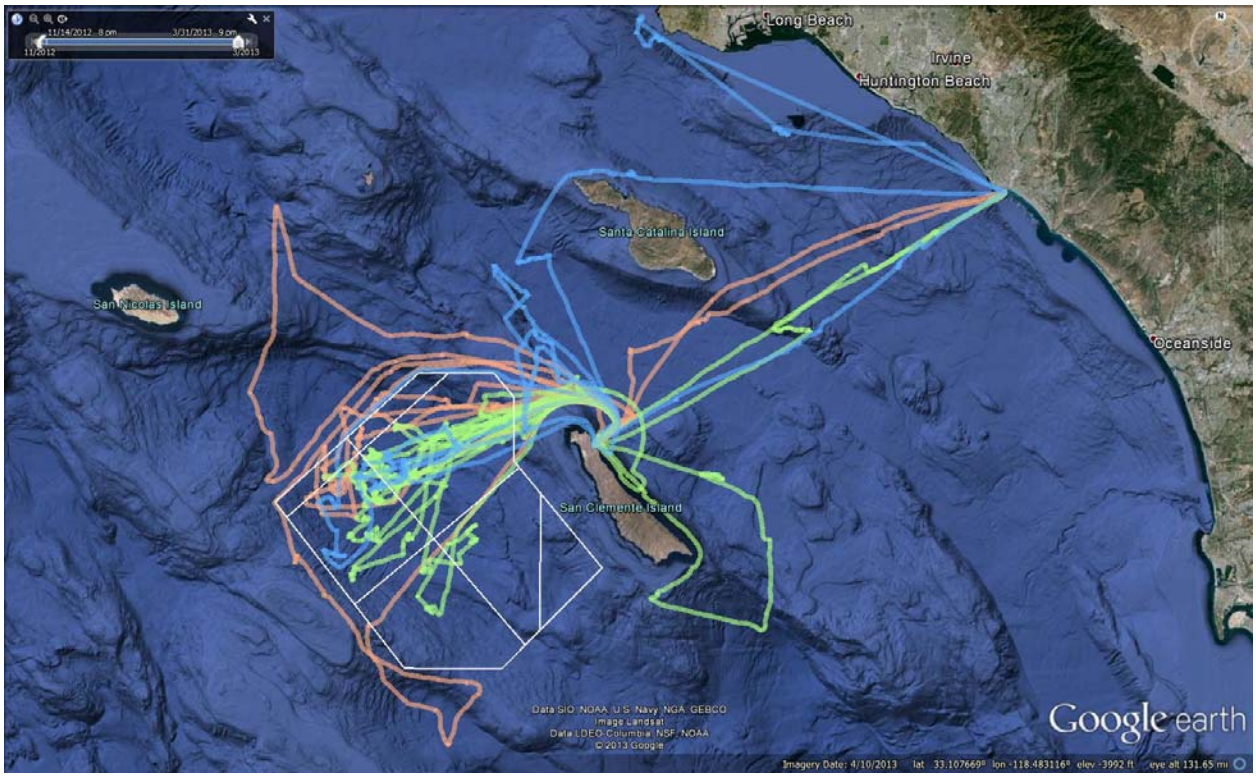

Figure 1. Vessel track lines from surveys conducted in year three. Tracks in orange are from November 2012, blue from January 2013, and green from March 2013. SOAR is outlined in white.

Thirteen cetacean species were sighted during these surveys (Table 2, Figures 2a-2b). Species assemblages were similar to those noted in prior surveys in cooler months of the year. Among baleen whales, fin whales continue to be prevalent year-round. In winter-spring surveys conducted in 2012 and 2013, moderately large and stable aggregations of fin whales were observed in both the outer waters near SCI and along the coast near the Palos Verdes peninsula. Many of these whales appear to be engaged in predominantly social behavior. On 18 November 2012, a very small fin whale calf with its mother was sighted milling on the SOAR range. This calf was visually estimated at 12-14' in length, which is at or below the minimum reported length at birth for this species, and was very likely born on or near SOAR in the days just prior to the sighting. This calf was the youngest fin whale that has been encountered in any of Cascadia Research Collective's (CRC) west coast surveys spanning more than 20 years. If there are calving areas consistently used by fin whales along the west coast, their locations remain elusive. However, the observation of a neonate calf and the highly social winter aggregations of fin whales observed off southern California in recent years may suggest that this region is gaining importance for reproductive activities, in addition to feeding, for fin whales.

Gray whales were again frequently detected moving through the near shore waters of SCI in January on their southward migration. Humpback whales were sighted more frequently during the 2013 March survey than during any previous survey effort in the area, with small groups of individuals apparently migrating northward through the SOAR range. The offshore migratory movements of west coast humpback whales are not well documented, so these observations of northbound whales in spring are valuable. A solitary Bryde's whale was sighted off Long Beach in January. While still uncommon at this latitude, this sighting adds to the growing number of records of this tropical species off the coast of California (Kerosky *et al.* 2012, Smultea *et al.* 2012), though most previous sightings and acoustic detections have been associated with warmer months.

This year added three more encounters with killer whales on SOAR, two of which were among the southernmost sightings of the "offshore" ecotype. The first group was initially detected acoustically on range sensors on 5 January, and visually and acoustically tracked as they moved south along the NE range boundary. The small group of four whales was traveling in association with several fin whales, as has been described in previous encounters with offshore killer whales (Dalheim *et al.* 2008). Two whales were satellite tagged and remotely tracked over the next several days-- see the satellite tagging section of this report for details of these deployments-- and when they passed along SCI again on 8 January they were resighted headed north through the same general area. This time there were several new killer whales with them. Though these groups were both smaller than the average group sizes reported for this ecotype, it is possible that they were part of a much larger, highly dispersed aggregation that is typical of offshore killer whales. The seasonality of these sightings was consistent with prior observations, which suggest offshore killer whales occur more frequently off southern California in winter. Identification photographs from these sightings were shared with killer whale researchers, who confirmed two individual group members have been seen historically off Monterey, CA, and as far north as British Columbia. On 23 March a group of transient killer whales was also encountered on the range.

We noted a reduction in the sighting rate of Cuvier's beaked whales, our highest priority species, during the second year of this grant. This low sighting rate persisted through the November 2012 and January 2013 surveys, until it appeared to rebound in March 2013. A slight northeast shift in distribution appears to have accompanied this resurgence, with both acoustic and visual detections occurring more often in the north central portion of the range, in contrast to previous detections which have been consistently biased toward the western range in all surveys at SCORE since 2006. The processes which drive the distribution of beaked whales in the region remain elusive. But as data sets such as this one slowly grow and increase in complexity, we hope to gain some insights into oceanographic or other patterns that might influence the whales' distribution in this area.

With regard to smaller odontocetes, common dolphins remain the dominant species throughout the study area at all times of year. As expected, cold water species including northern right whale dolphins and Dall's porpoises were sighted more frequently in the waters around SCI in January and especially March. However Pacific white-sided dolphins, another cold water species usually present off the coast of Southern California in winter and spring, were not sighted in this study year. Risso's dolphins continued to be sighted regularly in deeper waters, usually just off the shelf of islands. There were few sightings of bottlenose dolphins, though this is most likely related to reduced effort in the shallower coastal waters in which this species is usually found.

Table 2. Summary during year three of cetacean sightings by species, including photo-ID, tissue samples collected, and satellite tags deployed.

Group	Species	Groups Sighted	Est Total Individuals	Avg Group Size	Estimated Photo-IDs	Tissues Samples	Tags Deployed
Baleen whales	Minke Whale (*Balaenoptera acutorostrata*)	2	4	2	4		
	Bryde's Whale (*Balaenoptera edeni*)	1	1	1	1		
	Fin Whale (*Balaenoptera physalus*)	44	108	2	95	10	15
	Gray Whale (*Eschrichtius robustus*)	9	18	2			
	Humpback Whale (*Megaptera novaeangliae*)	7	11	2	4		
Beaked whales	Cuvier's Beaked Whale (*Ziphius cavirostris*)	8	25	3	20		3
Delphinids and porpoises	Common Dolphin, Sub-species unknown *(Delphinus*)	7	1175	168			
	Long-beaked Common Dolphin (*Delphinus capensis*)	10	983	98			
	Short-beaked Common Dolphin (*Delphinus delphis*)	9	3130	348			
	Risso's Dolphin (*Grampus griseus*)	21	283	13	59		1
	Northern Right Whale Dolphin (*Lissodelphis borealis*)	12	1245	104		1	
	Killer Whale, Offshore Ecotype (*Orcinus orca*)	2	12	6	11	2	3
	Killer Whale, Transient Ecotype (*Orcinus orca*)	2	14	7	7		1
	Dall's Porpoise (*Phocoenoides dalli*)	5	40	8			
	Bottlenose Dolphin (*Tursiops truncatus*)	3	87	29			
	Totals				**201**	**13**	**23**

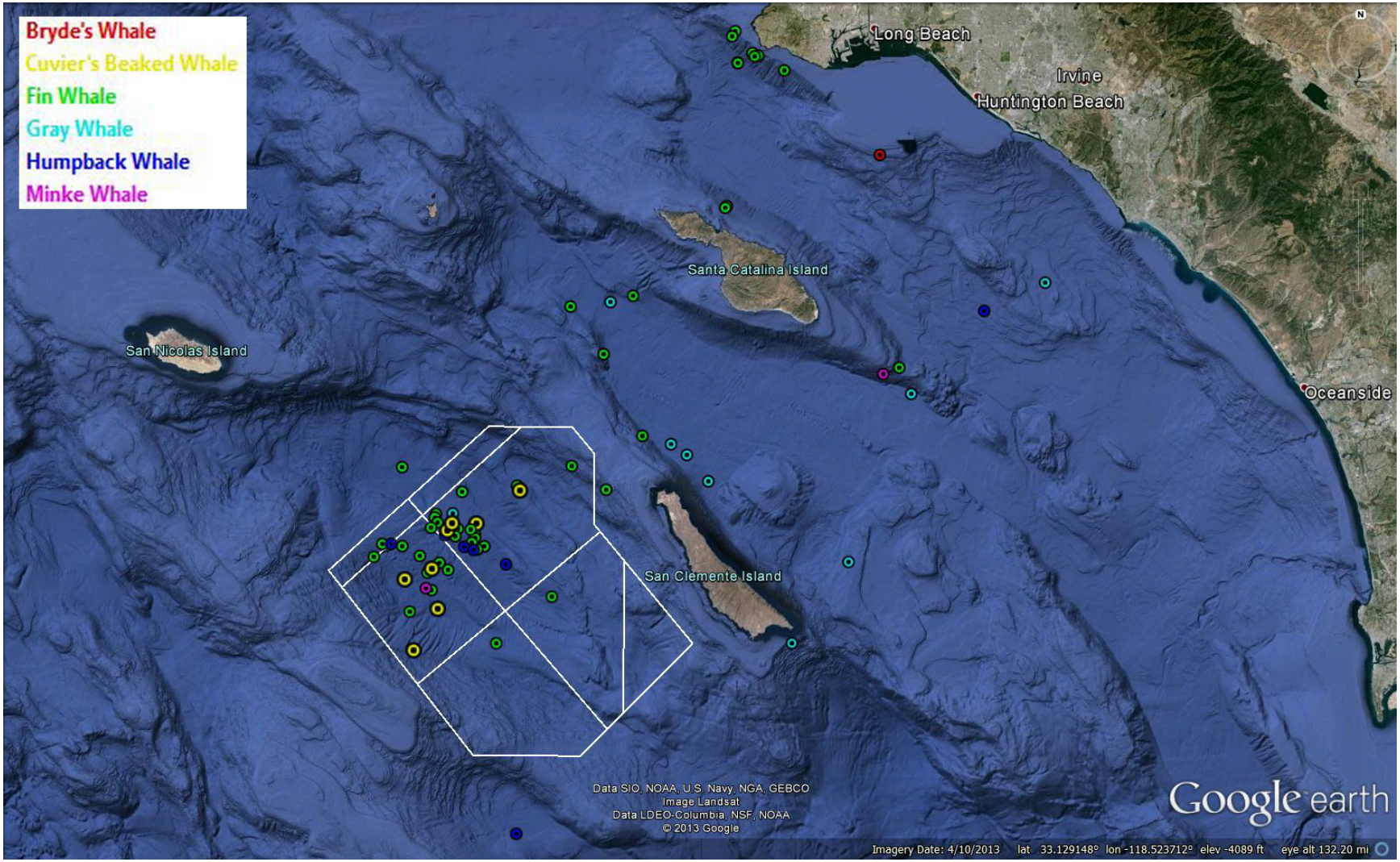

Figure 2a. Sightings of baleen and beaked whales in November 2012, January 2013, and March 2013.

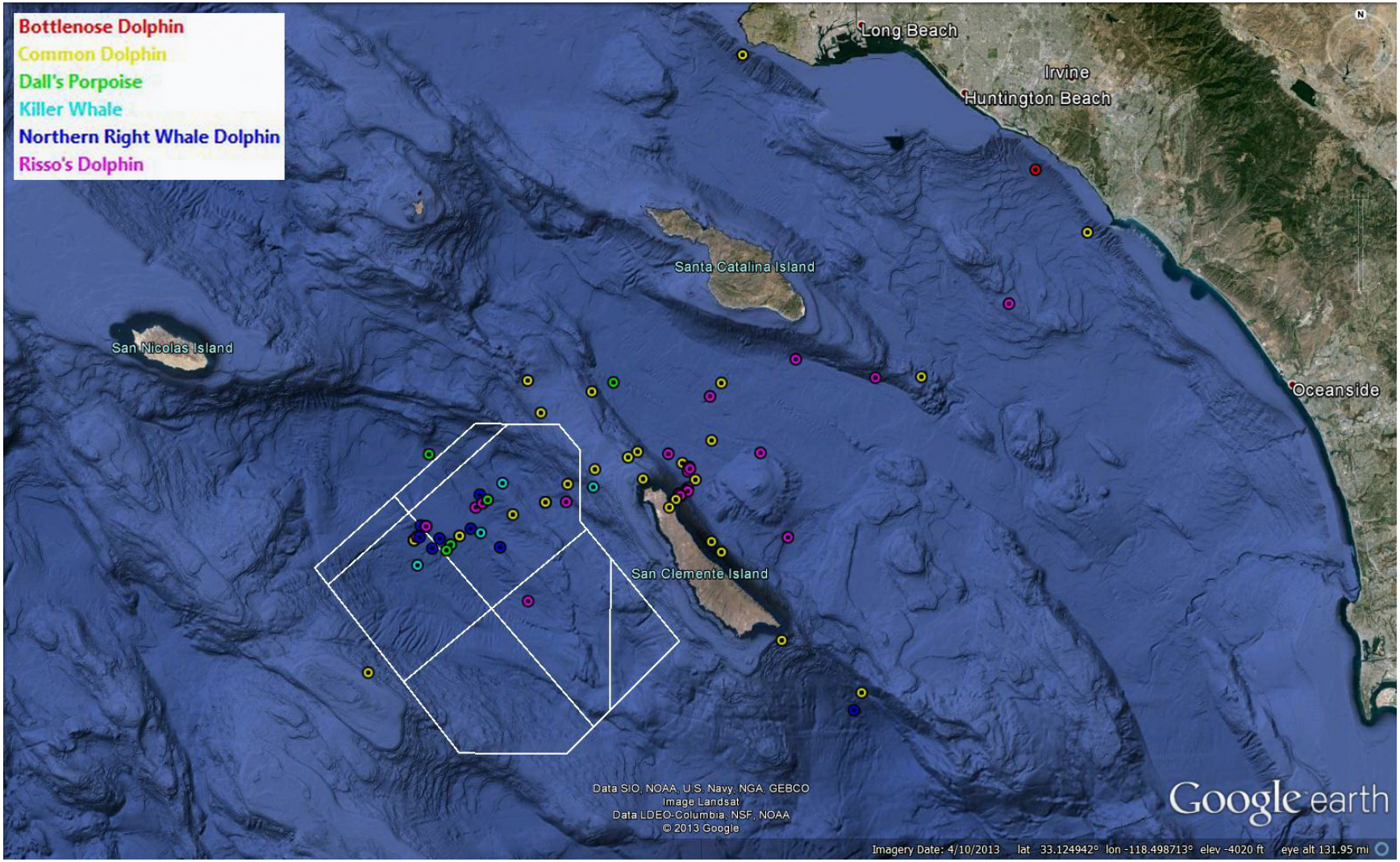

Figure 2b. Sightings of delphinids and porpoises in July 2012, November 2012, January 2013, and March 2013.

Photo-Identification

Individual identification photographs were collected from eight species during year three (Table 2). Photographs from six of these species were contributed to other ongoing photographic studies managed by CRC or collaborators; photos of Cuvier's beaked whales and fin whales were processed as part of this project. Photo-ID data are processed for each species across all data sources on a calendar year basis; thus detailed results of photographic comparisons are not available until the following year. Here we provide photo-ID data collection summaries for this study year, and match results for previous years.

Photo-ID: Cuvier's Beaked Whales

There were 25 Cuvier's beaked whales sighted during the study period, with identification photos collected from an estimated 20 of these individuals. The majority were photographed in 2013, and thus their catalog IDs are not yet available; however, at least four of these whales have been photographed at SCORE in prior years. The photographic catalog for Cuvier's beaked whales in southern California is small, totaling 108 unique individuals through the end of 2012, if all whales are included regardless of which sides of the body were photographed and regardless of image quality. (This means that some of these whales may actually have been counted twice if they exist in the collection either as unlinked left and right sides or as missed matches due to low image quality.) This small catalog size is due in part to the low encounter rate with this species, but also because preliminary photo-ID results suggest the population itself may be less than 200 whales. The first two Cuvier's beaked whales were identified at SCORE in 2006, and since then an average of 21 individual whales have been identified each year during this and other projects in the region. The proportion of whales each year that have been identified in a previous year has risen steadily, nearing 40% by the end of 2012 (Table 3). A more rigorous mark-recapture population estimate is planned in the coming year when the 2013 data set is finalized, as another year with a moderate resighting rate will greatly improve the analytical strength of this small data set. A detailed review of body size, mark rates, and genetic data is also presently underway to more accurately assign sex and age class to each whale in the catalog, which may in turn allow us to compare the demographic structure of this population to well-studied populations of Cuvier's beaked whales in other regions where anthropogenic effects, particularly exposure to Mid-Frequency Active (MFA) sonar, is expected to be much lower.

Table 3. Cuvier's beaked whale annual photo-ID results. This table displays the total number of unique whales photographed each year, the number of these that had not been identified in a prior study year ("New"), the number which were previously identified ("Old"), and the corresponding annual resighting rate to previous years.

Year	Individuals Identified	New Individuals	Previously Identified Individuals	Resighting Rate
2006	2	2	0	0%
2007	28	28	0	0%
2008	27	26	1	4%
2009	8	8	0	0%
2010	18	15	3	17%
2011	27	18	9	33%
2012	18	11	7	39%

Photo-ID: Fin Whales

Of 108 fin whales sighted during this study period, 95 were photographed for identification purposes. Photographs from 2012 are currently being compared to the fin whale catalog, and those from 2013 will be compared once 2012 results are finalized. This catalog currently contains 438 eastern North Pacific fin whales identified from 1987 - 2011 at points from northern Baja California to southeast Alaska, though the majority were from southern California (Table 4), due in large part to the contribution of this project. Though the regional bias in this collection limits the inferences that can be made regarding extra-regional movements of whales, comparisons continue to suggest these occur relatively infrequently, with only four whales sighted in Southern California and also north of Point Conception and one Southern California whale also sighted off Baja California. In contrast, many whales photographed in southern California are documented in the region in multiple years (Table 5) and may be present in the region for extended periods year-round. Sixty whales have been seen in Southern California on more than one day per calendar year (maximum = 12 days annually), with spans between first and last day identified as long as 211 days (mean = 32 days). Surveys in 2012 and 2013 will provide the first significant numbers of fin whale identifications from winter and early spring; however, even the existing collection, with a seasonal bias toward summer and fall data, has revealed that 38 individuals seen off southern California were

present in more than one season (14%), with four seen in three or four seasons. This emerging pattern of resightings continues to hint that there may be a smaller, year-round sub-population of fin whales in the Southern California Bight. If so, these whales may require special management considerations in the future, given their elevated exposure to anthropogenic effects (such as concentrated large ship traffic and navy training exercises) in what appears to be favored habitat.

Table 4. Regional and annual composition of CRC fin whale photo-ID database and catalog through 2011. The catalog contains 438 unique individuals, five of which have been seen in more than one region.

Region	First Year	Last Year	Identifications	Unique Individuals	Avg Sightings per ID
British Columbia-Southeast Alaska	2004	2009	92	48	1.92
Oregon-Washington	2005	2011	49	44	1.11
Northern California	1987	2011	57	51	1.12
Southern California Bight	1992	2011	530	279	1.90
Baja California	2003	2011	29	21	1.38

Table 5. Annual photo-ID results for fin whales photographed off Southern California during this project and other collaborative efforts. This table displays the total number of unique whales photographed each year, the number of these that had not been identified in a prior study year ("New"), the number which were previously identified ("Old"), and the corresponding annual resighting rate to previous years.

Year	Individuals Identified	New Individuals	Previously Identified Individuals	Resighting Rate
1992-2005	74	64	10	14%
2006	24	21	3	13%
2007	35	33	2	6%
2008	45	38	7	16%
2009	54	50	4	7%
2010	64	49	15	23%
2011	38	24	14	37%

Satellite Telemetry

Twenty-six LIMPET satellite tags were deployed on five species (Table 6) in the period from 1 July 2012 through 30 June 2013. Three of these tags were deployed during collaborative field efforts in the study area to improve seasonal coverage in the existing data sets. This year we shifted toward the use of Mk10-A satellite tags (20 deployments), which provide both Argos locations and dive data. While these tags provide a more comprehensive view of behavior and habitat use, they typically transmit for shorter durations than the location-only tags, as dive data collection and transmission consumes battery power more rapidly. However, one of these tags (Oo Tag 035) malfunctioned upon deployment and only transmitted intermittently, resulting in an unusually long, though sparse, location-only track. Excluding this tag, location/dive data sets averaged 27 days' transmission duration. The remaining six location-only tags transmitted on average for 45 days. Two tags, one of each type, failed to transmit.

Table 6. Summary of satellite tag deployments in year three.

*Denotes tags deployed during collaborative field efforts in the study area.

**Denotes tags with anomalous data transmissions and which are excluded from species-specific data summaries later in this report.

Species	TagID	Deploy Date	Transmission Duration (Days)	Data Type
Cuvier's Beaked Whale	Zc Tag 021	3/29/2013	47	Location/Dive
	Zc Tag 022	3/30/2013	28	Location/Dive
	Zc Tag 023	3/30/2013	7	Location/Dive
Fin Whale	Bp Tag 045	11/17/2012	54	Location/Dive
	Bp Tag 046	11/17/2012	No Tx	Location
	Bp Tag 047	1/5/2013	No Tx	Location/Dive
	Bp Tag 048	1/5/2013	28	Location/Dive
	Bp Tag 049	1/5/2013	3	Location
	Bp Tag 050	1/5/2013	6	Location/Dive
	Bp Tag 051	1/8/2013	45	Location/Dive
	Bp Tag 052	1/13/2013	86	Location
	Bp Tag 053	1/16/2013	22	Location
	Bp Tag 057**	3/23/2013	13	Location/Dive
	Bp Tag 058	3/23/2013	14	Location/Dive
	Bp Tag 059	3/29/2013	10	Location/Dive
	Bp Tag 060	3/29/2013	11	Location/Dive
	Bp Tag 061	3/29/2013	11	Location/Dive
	Bp Tag 062	3/30/2013	44	Location
	Bp Tag 063*	5/19/2013	82	Location/Dive
Killer Whale, Offshore Ecotype	Oo Tag 034	1/5/2013	73	Location
	Oo Tag 035**	1/5/2013	147	Location/Dive
	Oo Tag 036	1/8/2013	66	Location/Dive
Killer Whale, Transient Ecotype	Oo Tag 042	3/23/2013	32	Location/Dive
Risso's Dolphin	Gg Tag 011	3/26/2013	14	Location/Dive
	Gg Tag 012*	5/21/2013	8	Location/Dive
Sperm Whale	Pm Tag 018*	7/27/2012	10	Location/Dive

Satellite Telemetry: Cuvier's Beaked Whales

Three location/dive data tags were deployed on Cuvier's beaked whales at SOAR in March 2013 (Figure 3). Two of these tags (Zc Tag 022 and Zc Tag 023) were deployed on adult males in the same large, loosely associated group of 9 individuals-- one of the largest groups we have seen in the area. Though they both remained on SOAR and in the same general area throughout their transmission durations, the whales do not appear to

have remained associated long beyond the tag deployments. Transmission durations from Cuvier's beaked whales tagged during this contract period (median = 28 days, n = 3) were again lower than those in the first year (median = 71, n = 5), but showed improvement from those in year two (median = 12, n = 3), when a tag integrity issue was believed to have compromised tag performance. As has been typical of most Cuvier's beaked whales tagged on SOAR, whales exhibited limited movements within and beyond the range (Table 7). The grand mean distance to deployment location for these three individuals was only 28 km, though midway through the transmission period Zc Tag 021 moved off SOAR into an adjacent basin to the southwest. With these deployments, Cuvier's beaked whales have now been documented on SOAR in all months, with prolonged use of the area occurring in all seasons. The apparent northeast shift in sightings and acoustic detections of Cuvier's beaked whales on SOAR in 2013 is also seen in satellite telemetry data from these three whales (Figure 4).

These three tags provided an additional 1008 hrs of dive data to the 3732 hrs collected previously during this study (Table 8). The summarized dive records from the 8 prior tag deployments have been submitted for publication and are in review at the time of this report. The combined behavioral records for all 11 tags are currently being assessed with a mixed effects model to describe factors which affect behavioral patterning in this species.

In addition to the three known instances already identified in 2010 and 2011 where tagged Cuvier's beaked whales were on SOAR and in close proximity to exercises involving MFA sonar, we have identified three more such occasions in 2012. The complex, collaborative process of modeling the movements and dive behavior of whales, compiling the concurrent movements and transmissions of the ships, and modeling the acoustic space around the animals during these exercises is ongoing and will continue in the coming year.

Table 7. Movement summaries for three Cuvier's beaked whales satellite tagged at SOAR.

Tag ID	Transmission duration (Days)	Avg dist to deploy (km)	Max dist to deploy (km)	Cum. straight-line dist (km)	Avg rate of displacement (km/hr)	Number of Locations	Locations within SOAR boundary
Zc Tag 021	47	54.8	121.7	942	1.10	132	49
Zc Tag 022	28	13.0	40.9	520	1.18	65	55
Zc Tag 023	7	15.4	36.5	147	0.71	24	24

Table 8. Summary of dive data collection for Cuvier's beaked whales through the current year.

TagID	Data Hrs	Deep Dives	Shallow Dives
Zc010	499.25	187	908
Zc011	544.74	129	846
Zc014	91.19	32	148
Zc015	1015.92	315	1617
Zc016	857.53	263	1054
Zc017	110.14	25	184
Zc019	172.50	53	282
Zc020	441.22	138	646
Zc021	625.55	199	1070
Zc022	284.35	101	503
Zc023	97.74	31	142
11 Tags	**4740 Hrs**	**1473**	**7400**

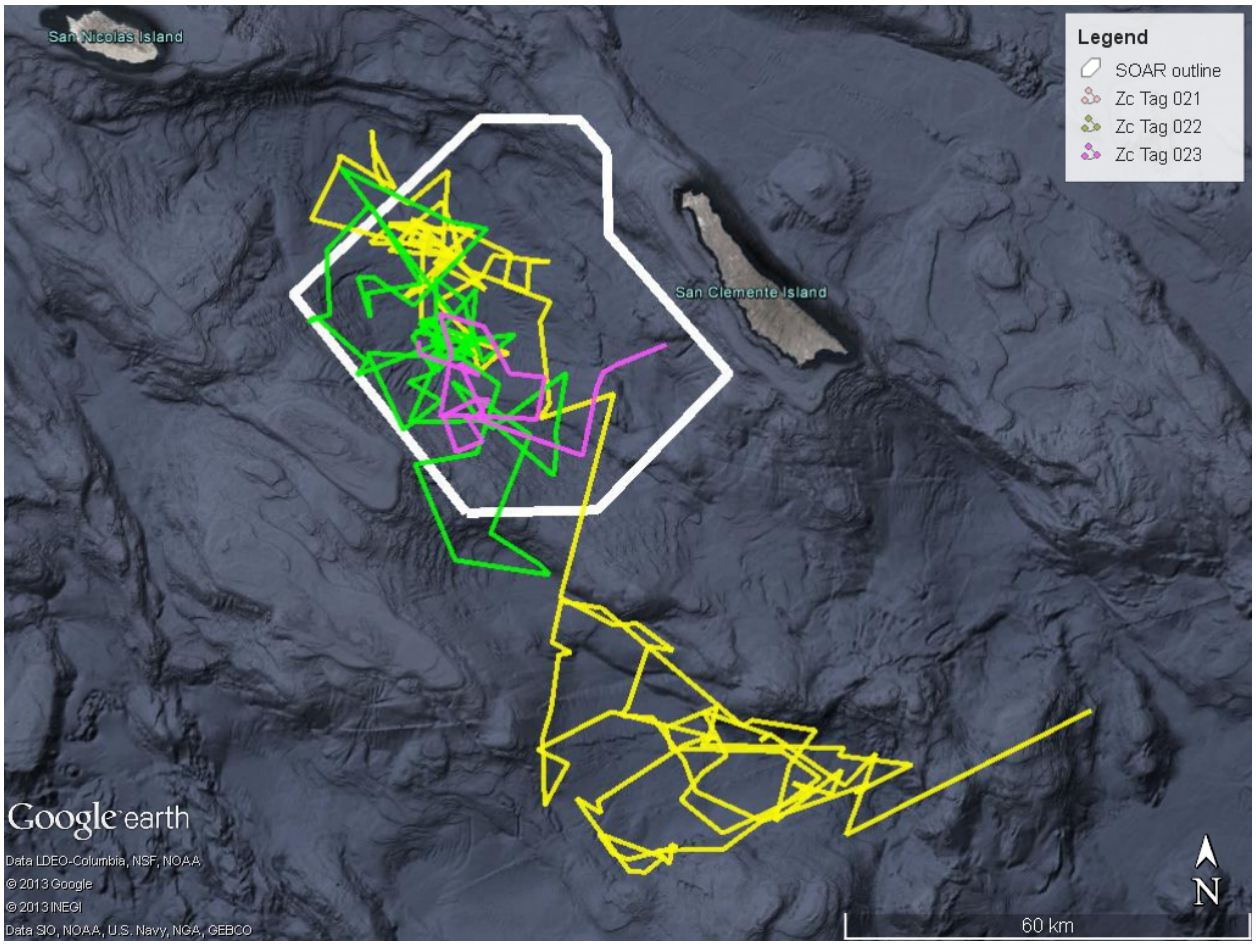

Figure 3. Movements of three Cuvier's beaked whales satellite tagged in year three. The pink and green tracks are from two whales tagged in the same group on 30 March 2013 (Zc Tag 022 and 023), while the yellow track illustrates movements of a whale (Zc Tag 021) tagged in the same area on the previous day whose tag transmitted for nearly three weeks longer.

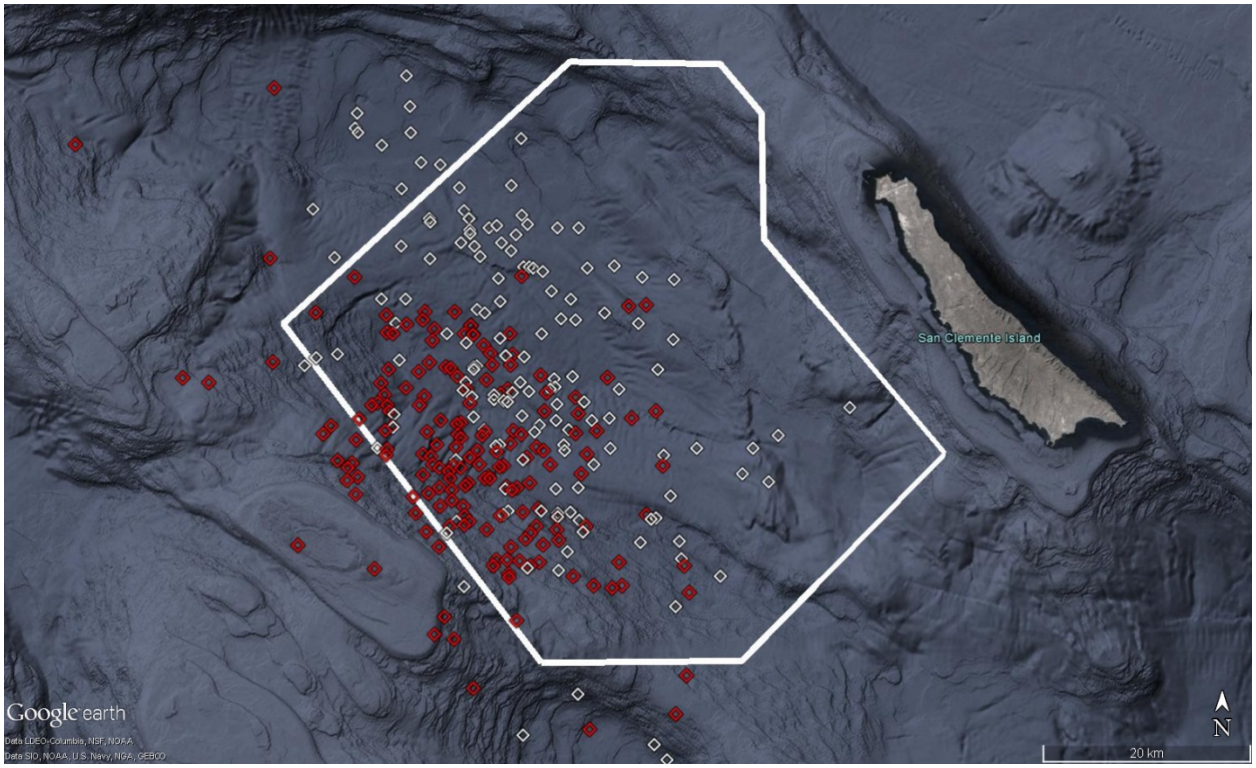

Figure 4. Daily locations from tagged Cuvier's beaked whales in the San Nicolas Basin, with locations from 2012 in red and 2013 in white. The SOAR boundaries are delineated in white. The shift in habitat use to the northeast in 2013 is apparent.

Satellite Telemetry: Fin Whales

Fifteen LIMPET satellite tags were deployed on fin whales during survey effort in year three; one additional tag was deployed during another collaborative project in the region in May 2013. All but one of these tags were deployed in the outer waters of the Southern California Bight and were spread from SOAR along the north end of SCI into the Catalina Basin to the north (Figures 5a and 5b). Two tags never transmitted data and one tag transmitted very poor quality data. These tags are excluded from tables and figures below (Table 9, Figures 5a and 5b).

The migratory patterns of fin whales in this region are not known; and as the regional sighting and photo-ID data are beginning to show, there is reason to question whether at least some whales in Southern California migrate consistently at all. Previous tag deployments on fin whales along the U.S. west coast failed to reveal any clear pattern. However, there was a trend for increased displacement rates and directionality in the spring and the fall, though there was no clear trend in which direction whales moved

(Falcone *et al*. 2011). That same pattern is apparent in Bp Tag 045 and Bp Tag 063, tagged in late fall and late spring, respectively, and to a lesser degree later in the transmission periods of Bp Tags 052 and 062, which were active in May 2013 when the whales moved further west. Only Bp Tags 045 and 063 made significant excursions outside the Southern California Bight, in this case to the west and south into Mexican waters, though Bp Tag 063 ultimately returned to the Bight during the transmission period, and Bp Tag 045 was en route to do so when the tag ceased transmitting. While neither of these patterns is characteristic of the types of migrations typical in other local baleen whale species, the tendency toward seasonal dispersion is perhaps relevant.

Nine of these fin whale tags provided dive data in addition to locations, augmenting the single deployment of this type of tag in 2012 (Table 10). These data have not yet been analyzed in detail, but represent the first combined long-term movement and dive records from this species, and they may also be able to shed light on subsurface behavioral changes that may accompany these seasonal trends in movement.

Table 9. Movement summaries for thirteen fin whales tagged in the Southern California Bight in late 2012 and early 2013.

Tag ID	Transmission duration (Days)	Avg dist to deploy (km)	Max dist to deploy (km)	Cum. straight-line dist (km)	Avg rate of displacement (km/hr)	Number of Locations
Bp Tag 045	54	515.5	1088	4404	4.3	353
Bp Tag 048	28	57.4	113	1848	2.0	322
Bp Tag 049	3	13.2	35	139	1.5	33
Bp Tag 050	6	19.9	37	271	0.9	72
Bp Tag 051	45	35.8	127	2373	2.1	394
Bp Tag 052	86	50.3	178	3416	1.8	482
Bp Tag 053	22	41.6	143	1321	2.0	193
Bp Tag 058	14	42.2	75	605	1.0	157
Bp Tag 059	10	13.8	29	489	1.6	89
Bp Tag 060	11	28.7	94	606	2.2	100
Bp Tag 061	11	16.0	28	423	1.3	78
Bp Tag 062	44	45.2	142	1717	2.0	215
Bp Tag 063	82	104.1	292	3074	2.1	283

Table 10. Dive data collection summary for all fin whales tagged with depth reporting tags through the current year.

TagID	Data Hrs	Dives
Bp Tag 045	619	1399
Bp Tag 048	499	2142
Bp Tag 050	87	510
Bp Tag 051	505	1672
Bp Tag 057	13	35
Bp Tag 058	258	1215
Bp Tag 059	114	383
Bp Tag 060	92	620
Bp Tag 061	102	350
Bp Tag 063	396	1539
10 Tags	**2685 hrs**	**9865 dives**

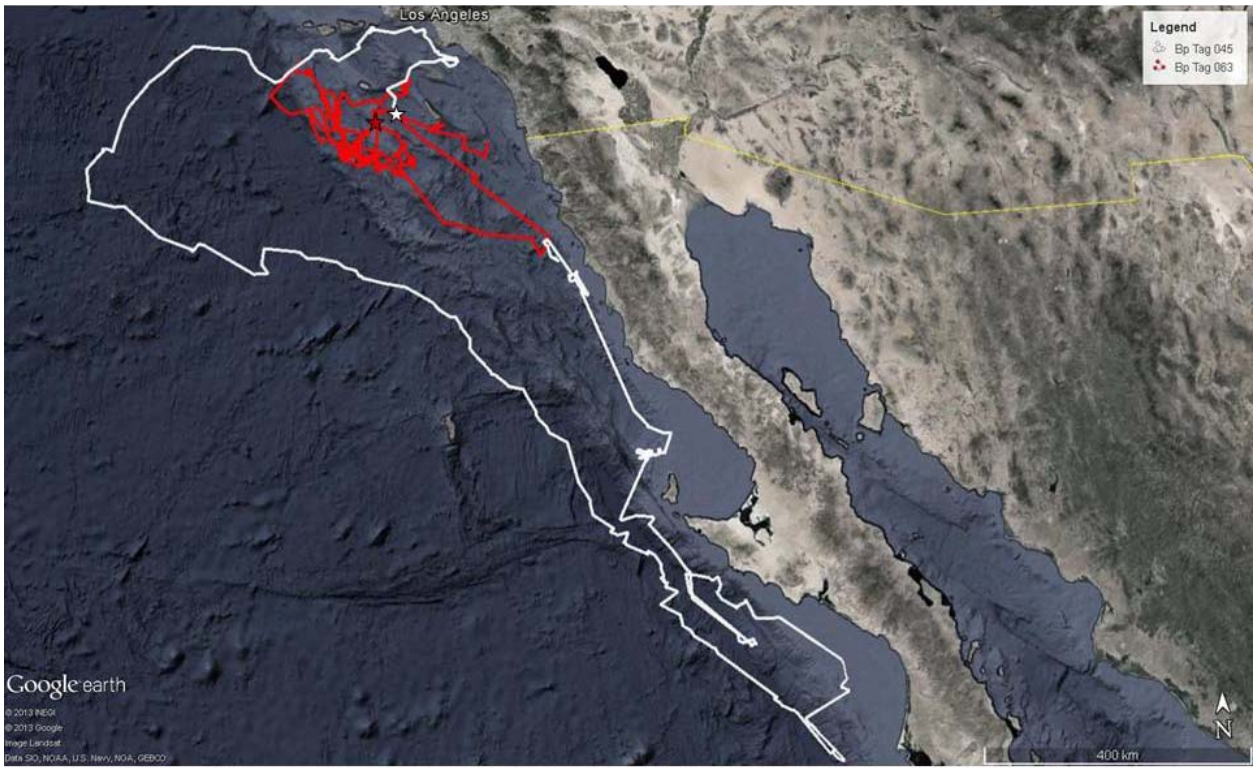

Figure 5a. Movements of Bp Tag 045 (white), deployed 17 November 2012, and Bp Tag 063 (red), deployed 19 May 2013. Only these two whales made significant excursions outside the Southern California Bight during the transmission period. Colored stars denote deployment location for each tag.

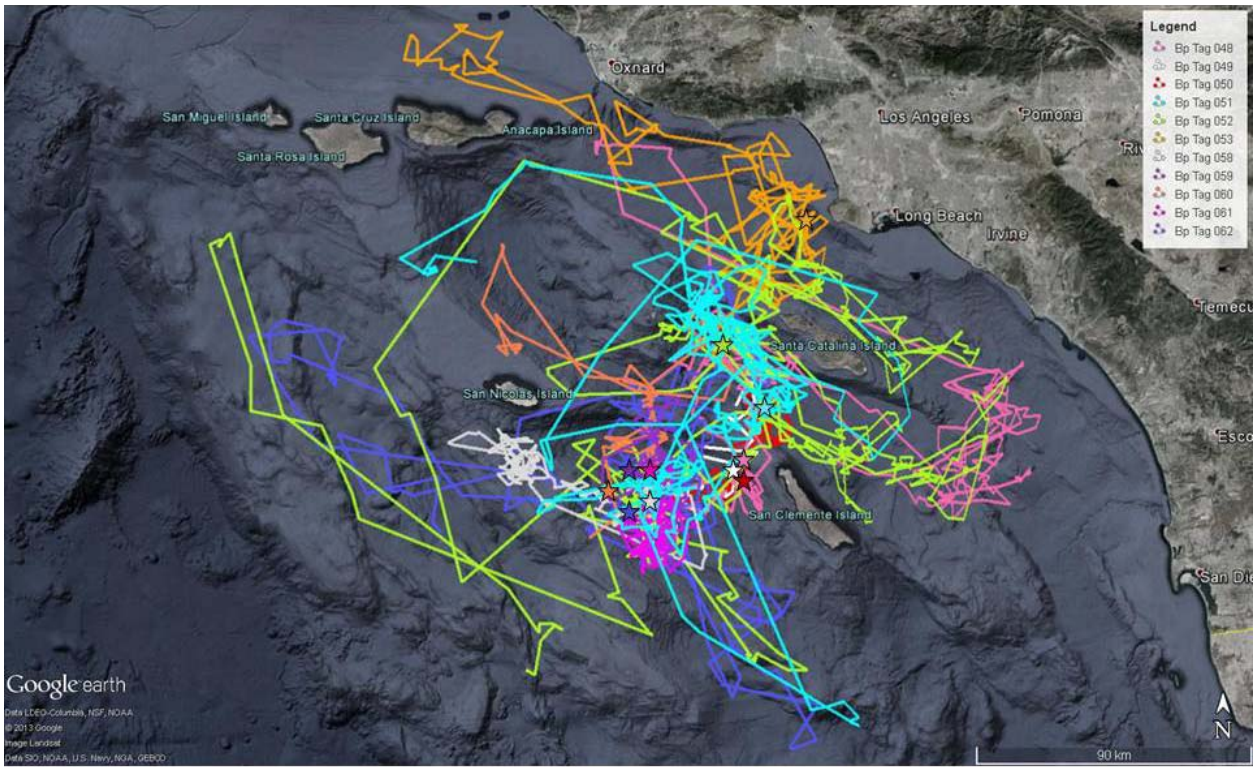

Figure 5b. Movements of eleven fin whales tagged in January and March 2013. Colored stars denote deployment locations for the track of the same color. These whales largely remained within the Southern California Bight throughout the transmission period, though some of the more extensive westward movements were seen from tags still transmitting later in spring.

Satellite Telemetry: Killer Whales

Four killer whales were tagged on SOAR during the contract period: three offshore ecotypes, and one transient ecotype (Table 11). Transmission durations for the offshores ranged from 66 - 148 days, during which they were documented from northern Mexico to Cook Inlet, Alaska. The longest transmission period was from Oo Tag 035, which malfunctioned and only provided 26 locations during the deployment. However, this included the longest overall displacement from tagging location-- over 3827 km.

Individual offshore killer whales have been photo-documented in the past at locations as far apart as Dutch Harbor, AK, and California, so large movements were not necessarily unexpected (Dahlheim *et al.* 2008). However, the data from Oo Tag 034 and Oo Tag 036 provided the first detailed record of habitat use and daily movement rates during the whales' lengthy transits (Figure 6a). From California north to central British Columbia,

the whales predominantly utilized waters along or just off the shelf edge. Upon reaching the southern tip of Haida Gwaii (the Queen Charlotte Islands), the animals moved inshore and onto the shelf, where they continued well into the inside waters of Southeast Alaska. The average distance to shore was 63 km, which underscores why these whales are seldom sighted during routine coastal surveys along the U.S. West Coast.

Oo Tag 042 was the only transient ecotype tagged during this study year. This whale moved more extensively than transient killer whales previously tagged in the region, though this tag also transmitted twice as long as the previous longest deployment. This whale also used a broader range of habitat than have other killer whales, including transits up to 200 km from shore (Figure 6b).

Oo Tag 036 and Oo Tag 042 provided dive data in addition to movements data for these two whales (Table 12). These are the first dive data ever collected from an offshore, and likely among the longest dive records collected from a transient.

Table 11. Movement summaries for four killer whales tagged in the Southern California Bight in 2013.

* Represents a tag that malfunctioned, providing only a few locations during the course of signal contact-- so movement statistics were not calculated.

Tag ID	Trans-mission duration (Days)	Avg dist to deploy (km)	Max Dist to deploy (km)	Cum. straight-line dist (km)	Avg rate of displac-ement	Number of locations	Ecotype
Oo Tag 034	73.2	890.4	2801.1	7538.7	4.14	833	Offshore
Oo Tag 035*	147.4		3827.3			26	Offshore
Oo Tag 036	66.2	448.4	1763.9	4397.6	4.36	75	Offshore
Oo Tag 042	32.0	214.5	735.6	3050.3	3.45	294	Transient

Table 12. Dive data collection summary for killer whales tagged with depth recording tags.

TagID	Data Hrs.	Dives
Oo Tag 036	174	500
Oo Tag 042	452	2810
2 Tags	**626**	**3310**

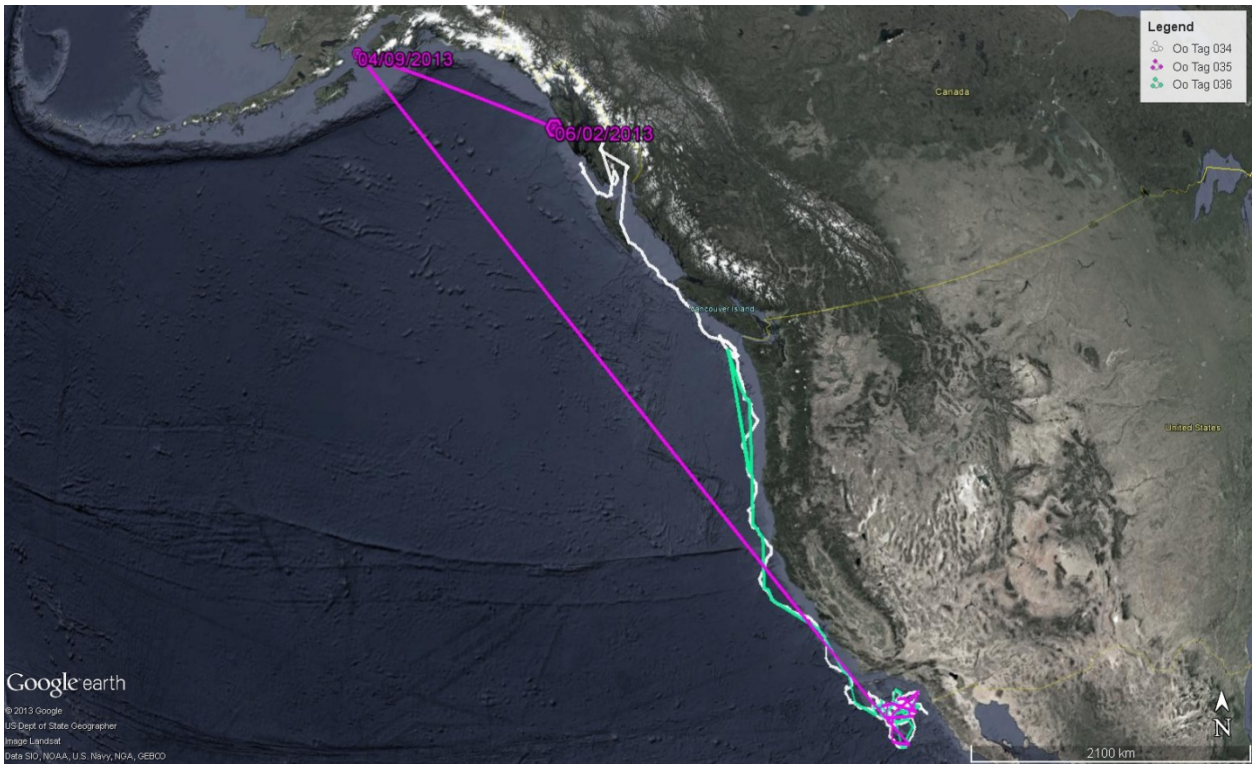

Figure 6a. Map of the offshore killer whale ecotypes that were tagged on SOAR during January 2013. Due to a tag malfunction, the pink track representing Oo Tag 035 should not be viewed as representative of the whale's actual track, only as a tool to visualize overall movements.

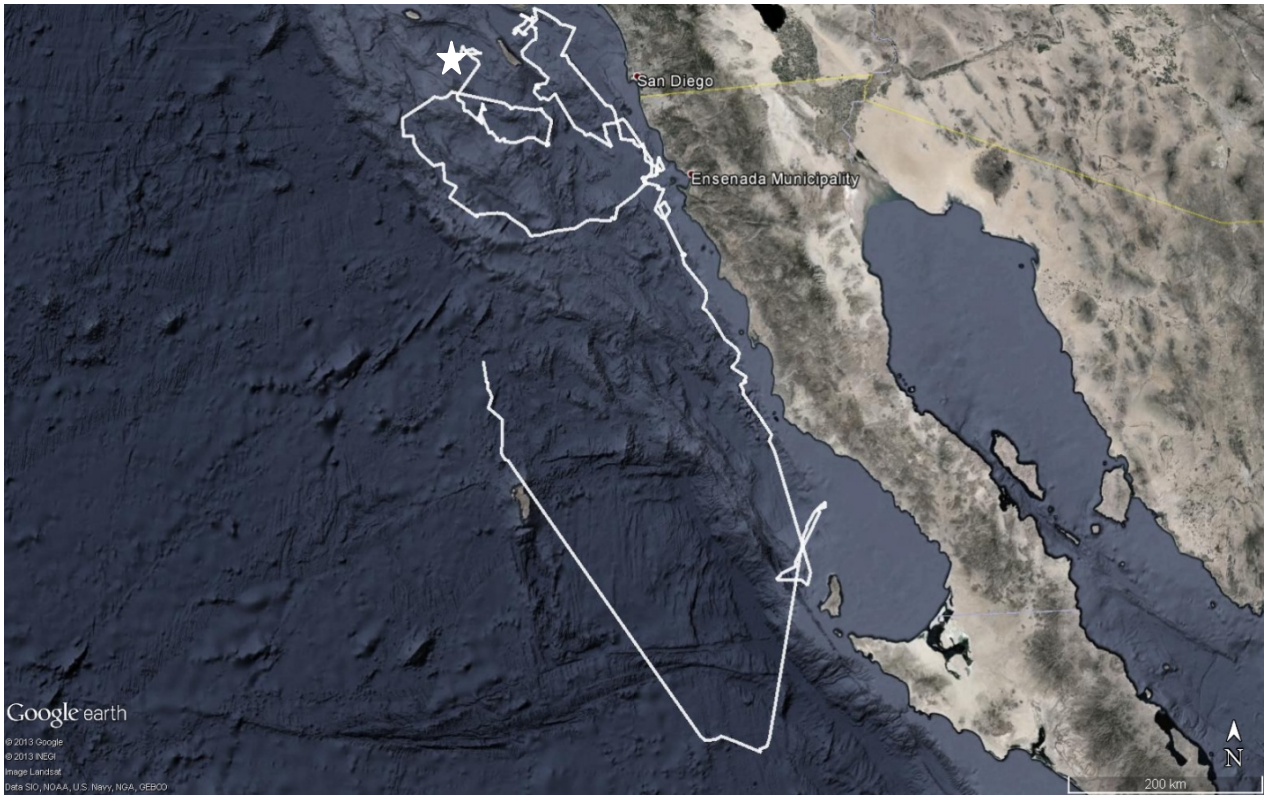

Figure 6b. Track of killer whale tagged on SOAR. (Star indicates tagging location.)

Satellite Telemetry: Risso's Dolphins

Two tags were deployed on Risso's dolphins during the reporting period. One tag was deployed just outside the boundary of the Shore Bombardment Area (SHOBA) at SCORE, and the animal spent three days within that range on the south side of San Clemente Island (Figure 7). The second was deployed in the Catalina Basin, southwest of Santa Catalina Island. Relative to tagged Risso's dolphins from 2012, both individuals were slightly less-associated with islands, preferentially using offshore basins and associated banks. Movements are summarized in Table 13. Both of these tags recorded dive data, though they have not yet been compiled.

Table 13. Movement details for Risso's dolphins tagged during year three of the contract.

Tag ID	Trans-mission duration (Days)	Avg dist to deploy (km)	Max Dist to deploy (km)	Cum. straight-line dist (km)	Avg rate of displac-ement	Number of locations
Gg Tag 011	13.9	51.6	86.7	1184.7	2.8	156
Gg Tag 012	8.0	38.5	58.6	537.0	2.7	60

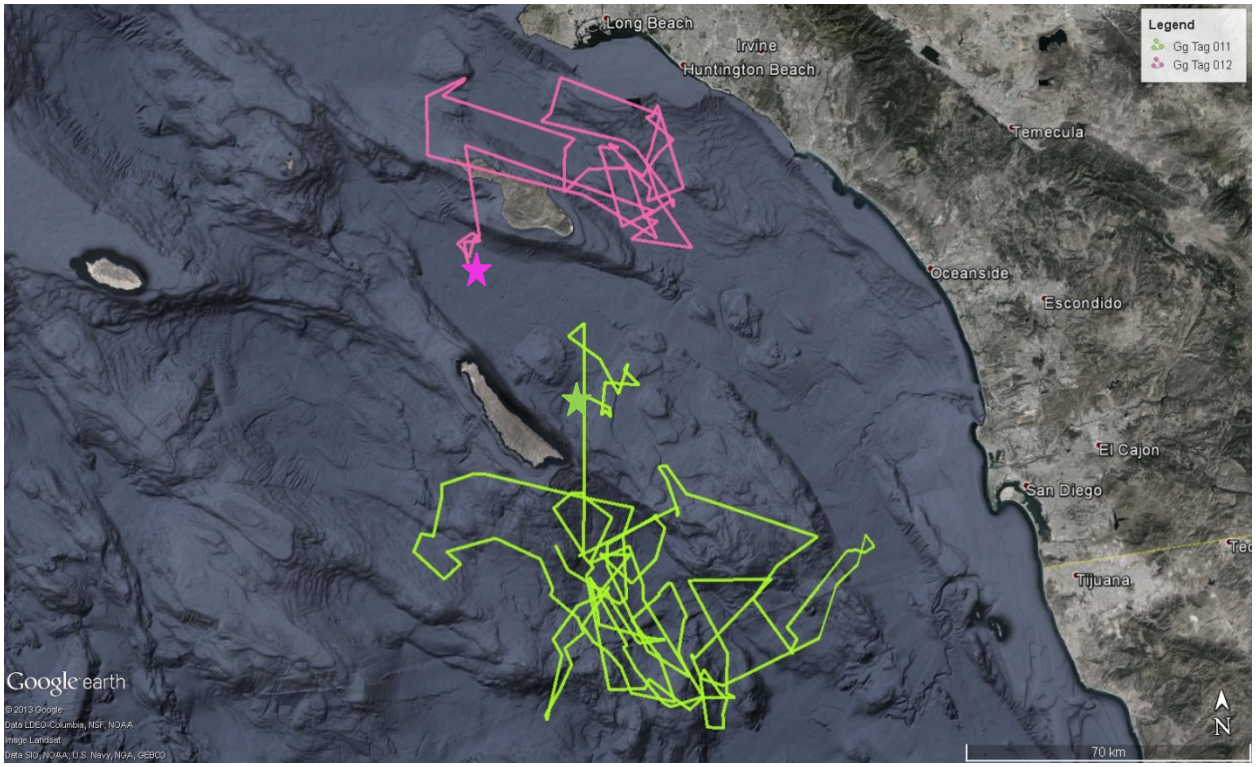

Figure 7. Movements of Risso's dolphins. Gg Tag 011 is represented by the green track, and Gg Tag 012 by pink. Tagging locations are indicated by the stars. Movements away from the islands near where the dolphins were tagged is apparent, with Gg Tag 011 spending much of the time in deep water south of San Clemente Island.

Concluding Remarks

The data gathered in the third year of this grant continue to provide new insights into the occurrence, distribution, habitat use, and behavior of cetaceans in the Southern California Bight-- the stated goal of

this grant. The long term movement and dive behavior records from Cuvier's beaked and fin whales on an active navy training range represent a unique data set for evaluating the interactions of these populations with military exercises. These analyses will become a primary focus of the last year of this contract.

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